



SOME REASONS FOR THE SUPPOSITION
THAT THE RED CORPUSCLES OF
THE BLOOD HAVE CYCLOIDAL ROTATION.

(WITH ADDENDA.) *1, and 2.*

PRESENTED
BY
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*Some Reasons for the supposition that the Red Corpuscles
of the Blood have Cycloidal Rotation.*

THE red corpuscle, (human), is of the form which is the best adapted for rotation, being a flattened disc of circular periphery, thinned towards the centre on both sides, thus approximating to the form of a ring, which is the form into which centrifugal force, generated by rotation, is known to dispose ductile matter—as, for instance, demonstrated by Dr. Plateau in his experiment with a globule of oil, made to rotate in a medium of similar specific gravity, such as water and spirit in the required proportion.

Vid.
Addenda
A.

Mechanical conditions for impressing and renewing rotation on bodies so adapted for its reception appear to exist in the greater or less sharpness of the curves of the great arteries near the heart; and I would observe, that while the whole of the curve of the aorta would be concerned for the rotation of the corpuscles thrown* to the greatest distance—as to the lower part of the body—so, for the parts nearer to the centre of circulation, there would proportionally be the shorter portions of the aorta, viz., that portion only between the heart and the points where on one side the innominata, and on the other the common carotid and subclavian are given off. The curves of the subclavians I assume to assist in fulfilling similar functions for the upper extremities. Possibly the curves of the pulmonary arteries, (though the corpuscles would not of course in them be red), for the lungs. ~~I do not, however, assume for the venous blood generally rotation of corpuscles, but the contrary.~~ I assume rotation in the red corpuscles in the pulmonary veins, and that such rotation assists in the stimulation of the left ventricle.†

Addenda
V. 2
I. J. and K.

What economical purpose would be apparently served by such rotation, in contradistinction to the mere translation of the red particles without rotation?—It would be for future investigators to determine such effects completely, but reasoning from what is to be seen in the phenomena of the gyroscope, it would seem that the first effect of rotation is to fix with an amount of

* If there be rotation, then, as rotation ultimately comes out in heat, probably there will exist a law of degree of rotation for distance,—something of the kind known in astronomy as “Bode’s law of distances” for the planetary bodies.

† It is notable that there are in the pulmonary veins no valves—cycloidal rotation would appear difficult where valves existed.

force, (varying with the velocity of rotation, specific gravity, and oblateness of form of the body), the axis and plane of rotation, so that if a blood disc were thrown into rotation with its long diameter in the direction of its translative motion, it would, by the above law, appear impossible that such a relation of the long diameter could ever be altered, although the plane of rotation might be made to swerve, as the plane of a disc does when a flat stone is thrown edgeways with rotation about its shortest diameter through the air, its edge will be still to the front, though its plane may swerve from the direction of a vertical plane to one approaching, for instance, the horizontal.

B. But the more important and practical question now presents itself—as to how far heat may be due to the arrest by the capillaries of the rotation of the discs? and it must be remembered that physiologists recognize that it is only in the higher vertebrata, and in the ratio as we proceed higher, that the red corpuscle becomes more perfect and developed.

It is certain that if the red blood discs do ordinarily rotate in human blood, a cessation of rotation must augment temperature; it has been seen that in the capillaries, the blood discs become elongated, having, in fact, become as it were compressed by entering so small a calibre; and of course such arrest of *translative* motion has already been recognized as a mechanical cause of heat. In disease, where rotation was arrested or hindered, before the capillaries are reached, heat would be further augmented by causes which are apparent.

The susceptibility of rotation of a *varying* degree of myriads of discs, might, in its adaptability to varying translatory impulse from the heart (as before described), constitute one of the chief “escapements,” or act as a fly-wheel to conserve and, if needful, concentrate force, (as in the instance below referred to of erectile tissue), and generally, in helping to maintain uniformity of temperature.

Heat and motion being assumed convertible, such rotation of red corpuscles might otherwise constitute one of the “escapements,” as between the heat equivalent of the force of the heart on the one

hand, and on the other by the constant escape of heat from the surface by evaporation, radiation, &c., as does the escapement of a watch in another form. It is remarkable that the temperature of the blood of birds is higher than the human, and that (as I understand) their red corpuscles are *prolate* and not *oblate* bodies; there might thus be in birds less easy translation, without rotation, and a less developed way of evolving heat, which might increase temperature, though probably in them still more due to increased oxidation.

Another possibly useful purpose might be served from the view that while the red corpuscle is supposed to be the chief vehicle of the iron that exists in the blood, it must be consequently involved in electrical and magnetic action—of which the body* is supposed to be at once a generator and a subject; that iron would be then in approximately the form of a rotating ring, its specific gravity known to be greater than that of the liquor sanguinis, (perhaps from the admitted greater predominance of iron in the corpuscle than in the liquor sanguinis), and it is thus better endowed both for rotation and translation than if its specific gravity were less. By the rotation there would be, (as stated above), an axis more or less fixed in direction, which we may call, in contradistinction to another, the mechanical axis, such as the axis of rotation of the earth, (omitting, at present, the nutation), though, as in the case of the earth, so also in the oblate red corpuscle, there may also exist another polar axis, but which, unlike the preceding, is neither an axis of symmetry, or fixed in direction, viz., a magnetic pole, which, in the earth, is supposed to be in slow oscillation; this, if it existed in the blood disc, might or might not be co-incident with the mechanical axis; thus there would be polarity, possibly of two kinds, in the blood.

The gyroscope illustrates that it is impossible to interfere with the direction of the axis or plane of any rotating body without a resultant,—a *tertium quid*,—presenting itself, *i.e.*, a movement of rotation which is *not* in, but intermediate to, the direction which the newly-applied force would have imparted to the body had it not

* Carpenter (by Power), Op. Cit., Page 581—"The electricity of man is most commonly positive, and irritable men of sanguine temperament have more free electricity than those of phlegmatic character. The electricity of women is more frequently negative than that of men." See also Page 580, Op. Cit. D.

been previously rotating ; it will hence appear that the behaviour of a body during translation is greatly affected by the fact as to whether or not it has also rotation ; of course the path of any projectile, (and the red corpuscle especially if it has in addition, as assumed, cycloidal rotation, may for the moment be so viewed), is described by its centre of gravity—whether the red corpuscle has its centre of gravity concentric or excentric in its mass remains to be seen. If it be the symmetrical and homogenous body, as described in Dr. Power's edition (1876) of Dr. Carpenter's Physiology, it may be presumed to be concentric, and I so believe ; but the point is of interest to me, as I have at intervals, since 1854, made experiments with discs as Projectiles, for cycloidal rotation—some not unlike blood discs in form—both concentric and excentric, from model guns ; (*vid.* papers quoted at end), and though I am bound to say that I could not succeed in making concentric discs, fired in a vertical plane, spin cycloidally, (as evidenced by their mode of striking a wooden target), yet *excentric* discs did so uniformly, under certain conditions. However, even from guns, concentric discs have been made, so I understand, to spin, by curving the gun slightly in a vertical plane—as done by Colonel Roberto, of the Sardinian Artillery,* the curve being very different in degree to the approximately semi-circular curve of the aortal arch, which seems to me enough to rotate concentric blood discs. If the disputed helicine arteries in erectile tissue do exist—and their existence seems to be supported by great authority, *vid.* Carpenter, Op. Cit.†—it seems to me that, at all events, a portion of the function of such curve may be assumed to be the giving, by the helicine direction, increased rotation to the red corpuscles ; for I assume such rotation, if it exists, to be then, necessarily, a vital property of the red corpuscle, and likely to add to its already well-established stimulating function upon the nervous and muscular tissues. E.

In the heart and lung, especially, of the viscera, would, in my view, a corpuscle, that is rotating, be more likely than one that

* Vide "Revue de Technologie Militaire," par L. Delobel, Tome II., 1857, in which volume is also an allusion to my first experiments in 1854, by Captain De Puydt, of the Belgian Artillery, who had subsequently conceived a similar idea.

† Page 365, Note—"Supported by the great authority of Henle ;" though by some other Physiologists denied.

ADDENDA, NO. 2,

ON ROTATION OF BLOOD DISCS, BY R. W. WOOLLCOMBE.

- (F.) A further instance of possibly supplementary provision for rotation (in aid of the means already stated), for due stimulation of the Brain, may exist in the sudden curves of the Internal Carotid and Vertebral Arteries just before they supply the Brain, and proceed to the circle of Willis. I would remark, that in the instance of the Internal Carotids, the *first* branches leaving those vessels immediately after their sharp curve, are the ophthalmic—certainly not in importance the least—and, than them—none more likely to have for their function, (if any arteries have), the conveyance of discs in swift rotation.
- (G.) Another instance, having relation to the stimulation of the muscular tissue of the Heart—may exist in the curves of the coronary arteries. I would draw a clear distinction between the respective effects on rotation given by an artery that is *helicine*, and one merely *curved in approximately but one plane*—in the latter, the (assumed) previously existing aortic cycloidal rotation, about the short diameter of the disc, would be little, if at all, interfered with—as regards direction of plane—though it would be increased or diminished *in amount*, according as the curve was in aid or the reverse—but, by a *helicine* curve, a result, very different, would be brought about, as seen in the gyroscope—and detailed in *Addenda, E.*
- (H.) It might probably be chiefly, if not wholly, for the execution of a function in which action, *of a reflex kind*, would be exceptionally in request, that such violent and compounded evolutions of the arterial disc, (*per* the super-imposed helical rotation) would be set up—and which, it may be remarked, could scarcely occur without a simultaneous disturbance of the electrical state (Note, p. 5, and *Addenda, D.*)
- (I.) Since writing the above Paper, and chiefly from consideration of the curves of the great sinuses of the Dura Mater, I have been led to modify my idea that there was rotation of discs in the arteries *only*;—the blood disc is not known to be materially changed in form after its passage through the capillary system—and seeing that it thus remains in a form of great oblateness, and hence, as before stated, one on which rotation must be easily impressed and maintained, and also a form that, on whatever diameter of which, rotation may have been set up, it (the rotation) is certain, eventually, to settle about the shortest or natural axis of rotation—remembering this, it does appear impossible that such curves as these alluded to could be traversed by such oblate bodies, without rotation being set up—of a similar kind, though less in degree than in the arterial discs.
- (J.) It is also notable that in the cerebral and cerebellar veins there are no valves—however, there are otherwise valves, numerous enough, between the head and the upper extremities, and the heart—how rotation could be set up in the discs in the veins of the extremities it is hard to see, unless it were given by the curves of the anastomoses of the veins between the capillaries and the large trunks—or, the divergences of the latter, as, for instance, those of the median cephalic and basilic from the median vein: and similarly, in the lower extremity—thus, both the Cavæ may discharge into the venous side of the heart discs with rotation.
- (K.) This view, I confess, relieves my mind from the difficulty indicated when writing the word “possibly” in the first page, in relation to the pulmonary arteries—as there does not seem to be as much curve in those vessels as in the aorta, and if the discs do already rotate in the right side of the heart, so much curve would not be needed, seeing that their destination is so near at hand, and, secondly, where their function *in* transformation is one so different to that of *when* transformed to the arterial disc.

does not rotate, to fulfil the functions which it is admitted, is the especial property in these organs of the blood disc to fulfil; stimulation of the left ventricle and material for due oxidation of the blood.

In conclusion I would say, that I have been led to these suppositions from having for the last twenty-two years had much in my mind, with occasional experiments, the subject of rotating discs as Projectiles, and have written some memoirs on that subject, which have been above referred to, and are below mentioned.

The brevity and crudeness of this memoir are, in a measure, due to my desire to place, without loss of time, before the profession, a view which, if of any importance, is one of vital concern as well to Pathology as to the Physiologist.

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Letter to Sir Howard Douglas "on the true application to Projectiles of the Excentric Principle."—*Printed for private circulation, March, 1856.*

Proceedings of the Royal Society for March, 1862, being "an account of some experiments with Excentric oblate bodies and discs as Projectiles."

Journal of Society of Arts for Oct. 24th, 1862, being a report of paper by author, read in Section G. of the British Association at Cambridge in 1862, "Projectiles with cycloidal rotation contrasted with those having helical or rifle rotation."

Transactions of the Devonshire Association for the advancement of Science, Literature, and Art, vol. for 1870, being "Remarks on the probable inapplicability of the rifle principle for vertical or mortar fire, and a suggestion of another method."

Proceedings of the (late) United Service Institute of Plymouth for 1874. Paper entitled, "Some remarks on the rotation of Projectiles."

Stoke, Devonport, June, 1876.

ADDENDA. No 1

(A.) The centrifugal force would, if operating during the formation of the disc, tend to dispose the iron (from its greater specific gravity) more about the equator than poles of the disc—thereby making it still more susceptible than before of rotation, and at the same time increasing the velocity of rotation, and this might constitute one of the chief reasons why tone is given to the blood by iron, and anæmia generally characterized by absence or deficiency of iron, (*vid.* Carpenter, 1876 Ed., P. 246, Sec. 181, *et sequent*, on disintegration and development of red corpuscles); the diffusion in a mass of any rotating ductile substance, of matter of greater specific gravity than its own, would, by such heavier matter being by its rotation thrown more about the equator than the poles, have an effect in facilitating rotation equivalent to increase of oblateness—this I conceive to obtain in the red corpuscle by its taking up iron in its (the discs) process of evolution from matter more amorphous.

(B.) Carpenter (Ed. of 1876), by Power, P. 233, at foot note, says "Manassein finds that agents or conditions which *lower* the temperature of the blood, as Muriate of Quinine, Alcohol, and acute anæmia, effect *enlargement* of the blood corpuscles, whilst they are *diminished* in size by agents *exalting* the temperature of the body, as Heat, Septicæmic Poisoning, and exposure to Carbonic Acid; they enlarge under exposure to oxygen.

From this I gather collateral evidence in favour of rotation, as the contraction (radially) of a rotating body increases its velocity of rotation, hence, also, its heat-producing powers, and *vice versa*.

(C.) The specific gravity of the corpuscles is about 1,088, and that of the fluid containing them about 1,028.—*vid.* Carpenter, *op. cit.*

(D.) As similar electric statics repel—probably blood discs would thereby be preserved from colliding with each other, and with the parietes of the arteries, similarly, be untouched by the liquor sanguinis, and be thus rotating *in vacuô*, the violation of which condition is known to be incompatible with life.

(E.) Such imposition of a helical rotation, (as about a long diameter of a blood disc), on a previously supposed cycloidal rotation (about the short diameter) would, apparently, as in the gyroscope, cause violent displacement of the plane of rotation, producing a tendency to rotation about a third axis—such a compound movement of the blood disc would, of necessity, excite great action, both simple and reflex, on the nerves concerned—and would hence probably constitute one of the most important factors in the execution of the functions of the tissue in question.

If these suppositions have foundation, there exists in the human microcosm a counterpart of the stellar universe outside it—spheroids necessarily more or less oblate, in translation—with cycloidal rotation—presumably *in vacuô*, and when imbued with vitality—as the planets and the red blood discs—in cycloidal rotation; others, as the burnt up venous corpuscles, and our satellite, which we suppose to be—just now—as a cinder—with translation, but rotation of but one revolution in each completed orbit. — In the

(In the latter)
Stoke, Devonport, July 4th, 1876.

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probably much less
than in the latter

rolling
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